Unit 3B

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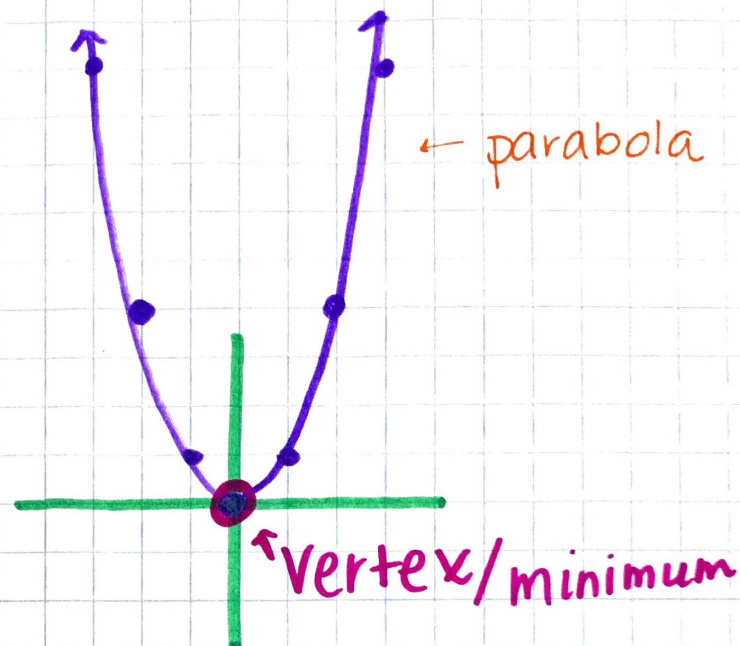
Parent Function

$f(x) = x^2$

x	y
-3	9
-2	4
-1	1
0	0
1	1
2	4
3	9



↳ Any quadratic w/out a stretch/shrink will have same width as the parent function

- count over 1 up from vertex
- for a stretch/shrink, "over" stays the same, but multiply the amount you go "up" by the a-value.

Vertex Form Notes

Vertex Form of a Quadratic

Today's Question: How do we graph quadratics in vertex form using transformations?
MCC9-12.F.BF.3

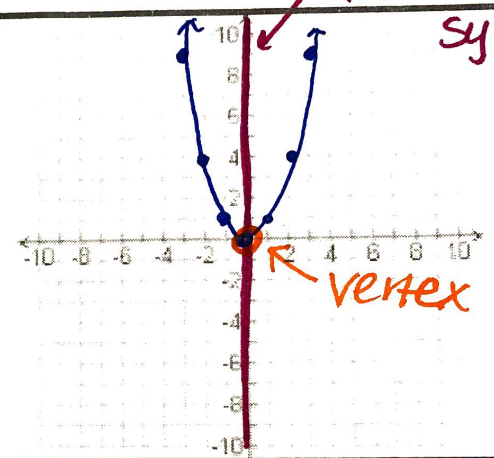
$$y = a(x-\underline{h})^2 + k$$

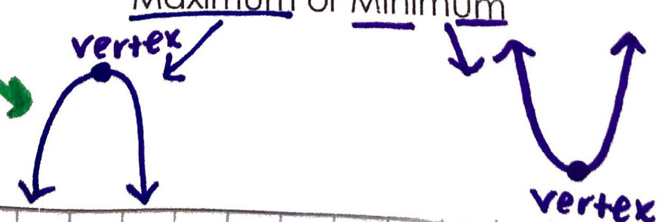
Vertex: ($\underline{h}$,k)

<u>Vertex</u>: The middle point of the graph also know at the maximum or minimum of the parabola.

The Parent Graph: $y = x^2$

	x	y
	-3	9
	-2	4
	-1	1
Vertex	0	0
	1	1
	2	4
	3	9



Letter	Transformation
stretch **a** reflect Shrink	$a=1$ no transformation $\lvert a\rvert>1$ Stretch $0<\lvert a\rvert<1$ Shrink $-a \rightarrow$ Reflect
h horizontal Shift	$(x-h)^2$ h+ Right $(x+h)^2$ h- Left
k vertical Shift	+k up -k down
Vertex (h,k)	Maximum or Minimum -a  +a

$$y = a(x-h)^2 + k$$

- Stretch
- Shrink
- reflect

$(x-h)^2 \to R$

$(x+h)^2 \to L$

+up

-down

Transformations Practice (h,k)

Practice Assignment

Name: ____________________

Date: ______________ **Block:** ________

Directions: For the following problems, describe the transformations and name the vertex.

1. $y = (x+1)^2 - 4$

   $(-1,-4)$

   Left 1 down 4

   h k

2. $y = (x-2)^2 + 2$ $(2,2)$

   right 2, up 2

   h k

3. $y = (x-3)^2 + 4$ $(3,4)$

   r 3 up 4

4. $y = x^2 + 5$ $(0,5)$

   up 5

5. $y = (x+2)^2$ $(-2,0)$

   left 2

6. $y = (x-4)^2 - 1$ $(4,-1)$

   R 4 d 1

7. $y = (x+10)^2$ $(-10,0)$

   left 10

8. $y = x^2 + 9$

   $(0,9)$

   up 9

9. $y = (x-7)^2 + 11$

   $(7,11)$

   R 7 up 11

Transformations

Graph from Standard

Graphing Quadratic Equations

UNIT QUESTION: How are real life scenarios represented by quadratic functions?

Today's Question: How do we graph quadratics in standard form? MCC9-12.F.IF.8

Steps for Graphing Quadratic Equations

$\frac{-b}{2a} = h$

1. Put the equation in standard form: $y = ax^2 + bx + c$
2. Identify the values of a, b, & c.
3. Find the axis of symmetry: $x = \frac{-b}{2a}$
4. Construct a table of values for x and y. You need a total of 5 points!
5. Plot the points and connect them with a U-shaped curve & arrows.

Examples:

Graph each using a T-chart. Use a dotted line to graph the axis of symmetry.

1. $y = -x^2 + 2x - 1$

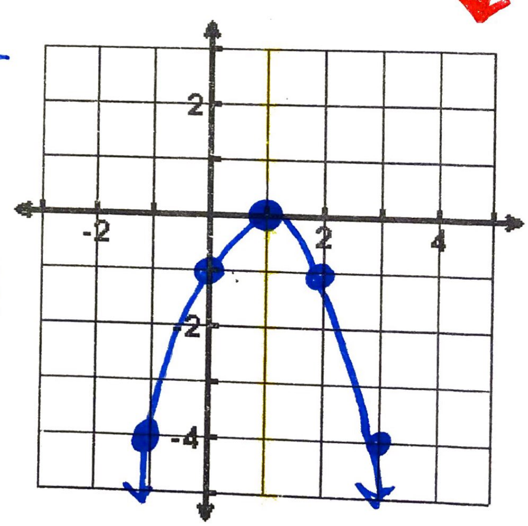
$a = -1$
$b = 2$
$c = -1$

x	y
-1	-4
0	-1
1	0
2	-1
3	-4

$\frac{-b}{2a} = \frac{-2}{2(-1)} = \frac{-2}{-2}$

$h = 1$

$f(1) = -(1)^2 + 2(1) - 1$
$= -1 + 2 - 1$
$f(1) = 0$



Extrema: max

Domain: $(-\infty, \infty)$

X-intercepts: $(1, 0)$

Increasing: $(-\infty, 1)$

Rate of Change $0 \le x \le 2$: 0

$(0,-1)$ $(2,-1)$ $\frac{-1--1}{2-0} = \frac{0}{2}$

Axis of Symmetry: $x = 1$

Range: $(-\infty, 0)$

Y-intercept: $(0, -1)$

Decreasing: $(1, \infty)$

Rate of Change $1 \le x \le 3$: -2

$(1,0)$ $(3,-4)$ $\frac{-4-0}{3-1} = \frac{-4}{2} =$

2. $y = x^2 - 6x + 5$

$a = 1$

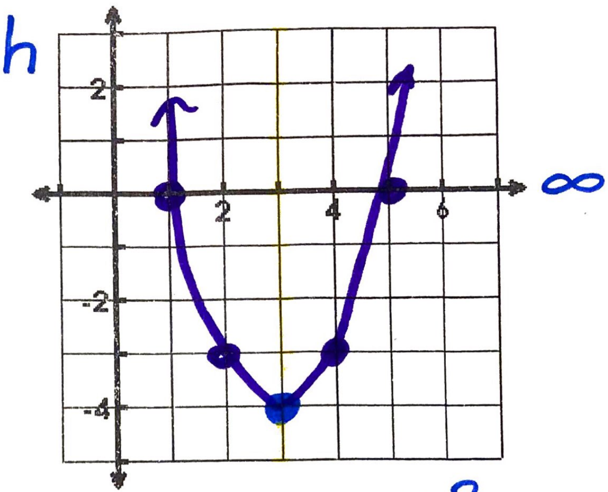
$b = -6$

$c = 5$

x	y
1	0
2	-3
3	-4
4	-3
5	0

$\frac{-b}{2a} = \frac{6}{2(1)} = 3 = h$

$f(3) = (3)^2 - 6(3) + 5$
$= 9 - 18 + 5$
$= -9 + 5$
$= -4$



Extrema: minimum

Domain: $(-\infty, \infty)$

Zeroes: $x = 5$ $x = 1$

Increasing: $(3, \infty)$

Rate of Change $0 \le x \le 2$: -4

(0,5)
(2,-3)

$\frac{-3-5}{2-0} = -8/2$

Axis of Symmetry: $x = 3$

Range: $[-4, \infty)$

Y-intercept: (0,5)

Decreasing: $(-\infty, 3)$

* Rate of Change $4 \le x \le 5$: 3

(4,-3)
(5,0)

$\frac{y_2 - y_1}{x_2 - x_1} = \frac{0 - -3}{5 - 4} = 3/1$

3. $y = -x^2 - 2x + 3$

$\boxed{a = -1}$

$b = -2$

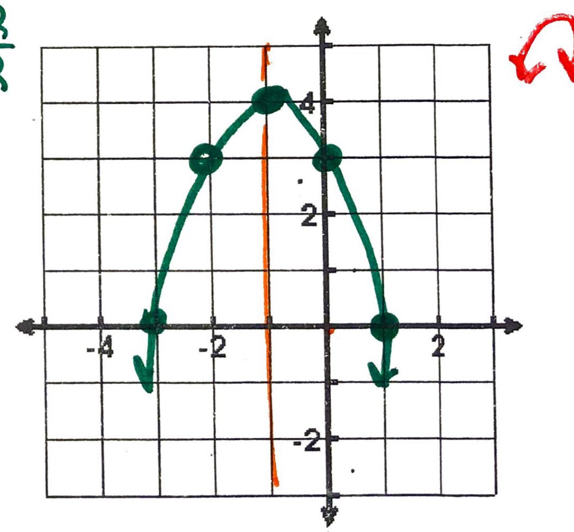
$c = 3$

x	y
-3	0
-2	3
-1	4
0	3
1	0

$\frac{-b}{2a} = \frac{2}{2(-1)} = \frac{2}{-2}$

$\frac{-b}{2a} = -1 = h$

$-(-1)^2 - 2(-1) + 3$
$-1 + 2 + 3$
4



Extrema: max

Domain: $(-\infty, \infty)$

zeroes Roots: $x = -3$ $x = 1$

Increasing: $(-\infty, -1)$

Rate of Change $0 \le x \le 2$: -4

$(2)^2 - 4 + 3$
$-4 - 4 + 3$

(0,3)
(2,-5)

$\frac{-5-3}{2-0} = \frac{-8}{2}$

Axis of Symmetry: $x = -1$

Range: $(-\infty, 4)$

Y-intercept: (0,3)

Decreasing: $(-1, \infty)$

Rate of Change $-3 \le x \le 1$: 0

Algebra 1 Name______________________ ID:

Warm up Graphing and Characteristics

Date________________ Period____

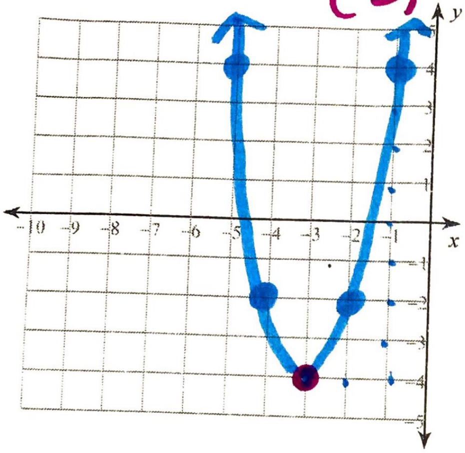
Sketch the graph of each function.

1) $y = 2(x + 3)^2 - 4$

(h, k)

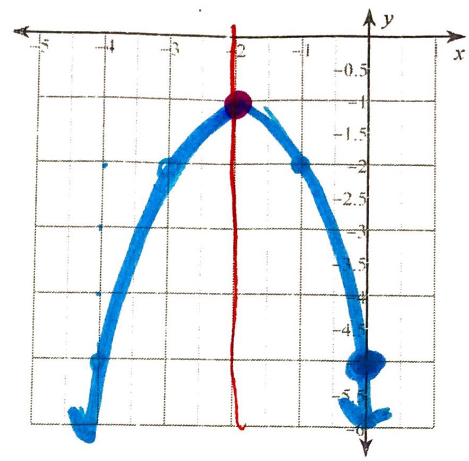
$(-3, -4)$

$a = 2$



2) $y = -(x + 2)^2 - 1$

$(-2, -1)$



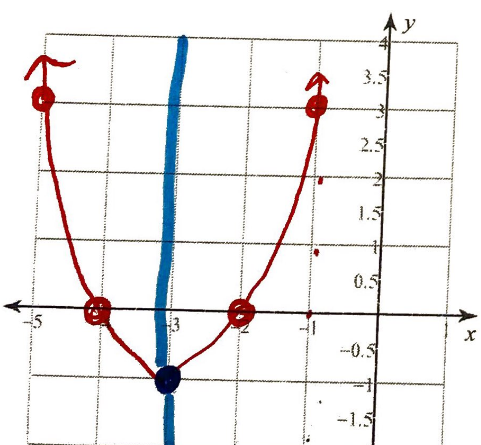
3) $y = x^2 + 6x + 8$

$\frac{-b}{2a} = \frac{-6}{2(1)}$

$= \frac{-6}{2}$

$\frac{-b}{2a} = -3$

$h = -3$



$f(-3) = (-3)^2 + 6(-3) + 8$

$9 - 18 + 8$

$-9 + 8$

-1

-1	3
-2	0
-3	-1
-4	0
-5	3

4) $y = -2x^2 - 4x + 2$

$a = -2$

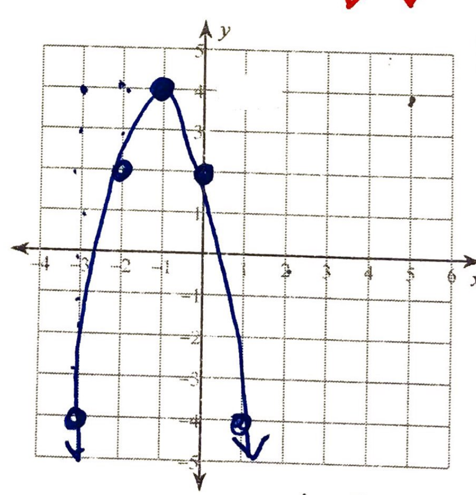
$b = -4$

$c = 2$

$(-1, 4$

$\frac{4}{2(-2)} = \frac{4}{-4}$

$h = -1$



$f(-1) = -2(-1)^2 - 4(-1) + 2$

$= -2(1) + 4 + 2$

$= -2 + 4 + 2$

$= 4$

Name: ____________________

Quadratic Characteristics

1.Vertex: $(-3,-4)$ Extrema: minimum Range: $[-4,\infty)$ Zeroes: x = -4.7 and x = -1.5	2. Vertex: $(-2,-1)$ Extrema: max Y intercept : $(0,-5)$ Interval of Increase: $(-\infty,-2)$ Interval of Decrease: $(-2,\infty)$
3. Vertex: $(-3,-1)$ Range: $[-1,\infty)$ Axis of Symmetry: $x=-3$ Interval of Increase: $(-3,\infty)$ Interval of Decrease: $(-\infty,-3)$ $x\to-\infty$ $y\to$ ∞ $x\to\infty$ $y\to$ ∞	4. Vertex: $(-1,4)$ X-intercept(s) : $(-2.7,0)$ $(.7,0)$ Y intercept : $(0,2)$ Interval of Increase: $(-\infty,-1)$ Interval of Decrease: $(-1,\infty)$ $x\to-\infty$ $y\to$ $-\infty$ $x\to\infty$ $y\to$ $-\infty$

Converting Forms of a Quadratic

Convert from vertex form to standard form (by multiplying out).

1. $f(x)=(x+4)^2+5$

$y=(x^2+8x+16)+5$

$\boxed{y=x^2+8x+21}$

2. $f(x)=-(x+3)^2-2$

$y=-x^2-6x-9-2$

$\boxed{y=-x^2-6x-11}$

3. $f(x)=2(x-2)^2-3$

$y=2(x^2-4x+4)-3$

$y=2x^2-16x+8-3$

$\boxed{y=2x^2-16x+5}$

Convert from vertex form to standard form by completing the square. Then, give the axis of symmetry and vertex.

4. $f(x)=x^2-8x+15$

$y-15+16=(x-4)^2$

$\boxed{y=(x-4)^2-1}$

5. $f(x)=x^2-4x+$ ___

$y+\underline{4}=(x-2)^2$

$\boxed{y=(x-2)^2-4}$

$\boxed{\frac{-b}{2a}}$

6. $f(x)=2x^2+12x+7$

$\frac{-12}{4}=-3$

$2(-3)^2+12(-3)+7$

$18-36+7=-18+7$

$=-11$

$\boxed{y=2(x+3)^2-11}$

Convert from vertex from to standard form by using x = -b/2a. Then, give the axis of symmetry and vertex.

7. $f(x)=x^2+4x+3$

$\frac{-4}{2(1)}=-2$

$(-2)^2+(4\cdot-2)+3$

$4-8+3$

$a=1$

-1

$\boxed{y=(x+2)^2-1}$

8. $f(x)=x^2-2x+5$

$\frac{2}{2(1)}=1$

$1^2-2(1)+5$

$1-2+5$

$a=1$

$-1+5$

4

$\boxed{y=(x-1)^2+4}$

9. $f(x)=2x^2-8x+17$

$\frac{8}{2(2)}=2$

$2(2)^2-8(2)+17$

$8-16+17$

9

$y=2(x-2)^2+9$

10. Find the axis of symmetry and vertex for the two functions

$-b/2a=h$

(h,k)

a) $f(x)=-16t^2+64t+10$

$\frac{-64}{2(-16)}=\frac{-64}{-32}=2$

$\boxed{x=2}$

$-16(2)^2+64(2)+10$

$-64+128+10$

$64+10$

74

$\boxed{(2,74)}$

b) $f(x)=-16t^2+64t+30$

$\boxed{x=2}$

$\frac{-64}{2(-16)}=2$

$-16(2)^2+64(2)+30$

$-64+128+30$

$\boxed{(2,94)}$

6

APPLICATIONS

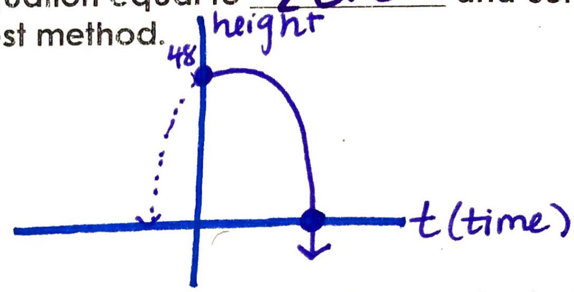
For a application problems, sometimes we will solve the equation, and sometimes we will be looking at the vertex.

Solving by quadratic formula
Is always an option!

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

"Hits the ground" is a key word for Solve!.

The height of the ground is zero, so set the equation equal to zero and solve with the best method.



1. A squirrel in a tree dropped an acorn 48 feet to the ground. The number of seconds, t, it took the acorn to reach the ground is modeled by the equation: $h(t) = -16t^2 + 48$. How many seconds did it take the acorn to reach the **ground**?

Best method: Square Roots

$$0 = -16t^2 + 48$$
$$+16t^2 \quad +16t^2$$
$$\frac{16t^2}{16} = \frac{48}{16}$$
$$\sqrt{t^2} = \sqrt{3}$$
$$t = \pm\sqrt{3} \approx \pm 1.73$$

$$\boxed{t = \sqrt{3} \approx 1.73}$$

2. Example: You launch a toy rocket from a height of 5 feet. The height (h, in feet) of the rocket "t" seconds after taking off is given by the formula $h(t) = -3t^2 + 14t + 5$

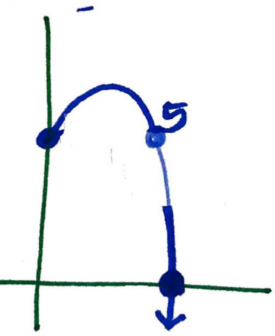
a) How long will it take for the rocket to hit the **ground**?

$$0 = -3t^2 + 14t + 5$$

$$x = \frac{-14 \pm \sqrt{(14)^2 - 4(-3)(5)}}{2(-3)}$$

$$x = \frac{-14 \pm \sqrt{256}}{-6}$$

$$x = \frac{-14+16}{-6} = \boxed{\cancel{\tfrac{-1}{3}}} \qquad x = \frac{-14-16}{-6} \qquad \boxed{x = 5}$$



b) Find the time when the rocket is 5 feet from hitting the ground.

$$5 = -3t^2 + 14t + 5$$
$$-5 \qquad\qquad -5$$
$$0 = -3t^2 + 14t$$
$$0 = t(-3t + 14)$$
$$\boxed{\cancel{t = 0}}$$
$$-3t + 14 = 0$$
$$-3t = -14$$
$$t = \frac{-14}{-3} = 4.\overline{6}$$

Sometimes we are looking at the vertex. Keywords for vertex: maximum or minimum.

We can always find the vertex using $-b/2a$.

$-b/2a$ is the x-value of your vertex, "h." We plug this value in to the function to find K, the y value of our vertex.

(h,k)

Time it takes to reach max

maximum or minimum value
* usually height

3. An object is projected into the air with a path described by the quadratic function **h(t) = −16t² + 32t + 106** where *h* is the height above the ground in feet and *t* is the time in seconds since the object started along the path.

$a=-16$
$b=32$
$c=106$

Vertex: (1,122)

$\frac{-b}{2a} = \frac{-32}{2(-16)} = 1$

a. At what **time** does the object reach its maximum height?

1 second

$-16(1)^2+32(1)+106$
$-16+32+106$
$16+106$
122

b. What is the maximum **height** of the object?

122 ft.

4. An object is launched and its path is given by the following function:

$h(t) = -4.9t^2 + 325t + 200$

Vertex: (33.16, 5,589.02)

$\frac{-325}{2(-4.9)} = 33.16$

x-value

a. How long does it take for the object to reach its maximum height?

$\boxed{33.2 \text{ seconds}}$

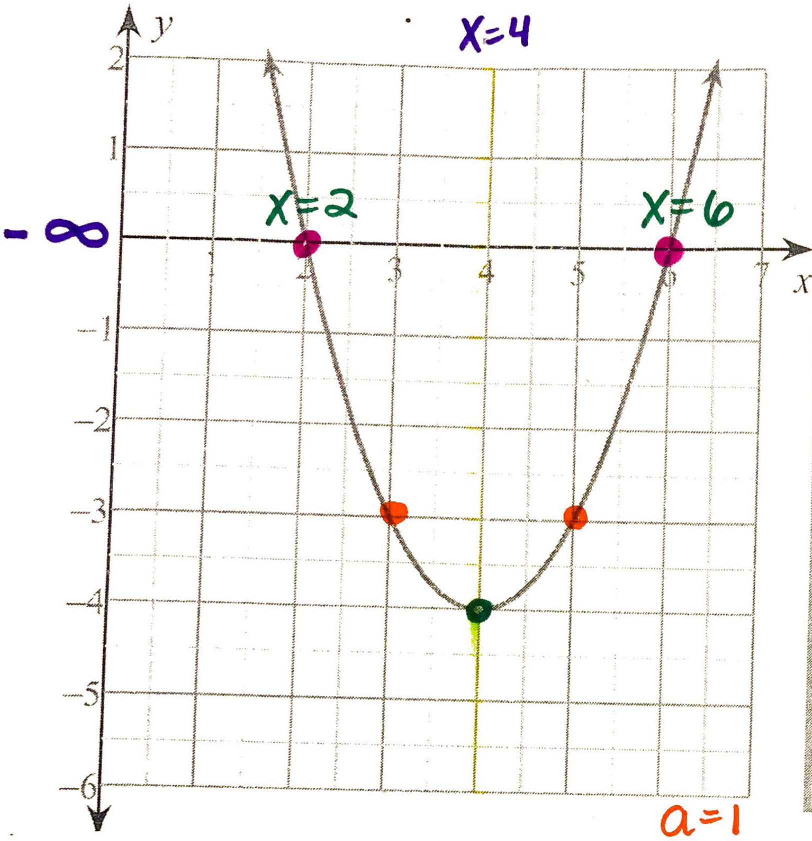
$h(33.2) = -4.9(33.2)^2 + 325(33.2) + 200$

b. What is the maximum height.

y-value

5,589.02 ft.

Analyzing Graphs: Test Review



Transformations: 1. down 4

2. Right 4

Vertex: 3. (4,-4)

Domain: 4. $(-\infty, \infty)$

Range: 5. $[-4, \infty)$

Axis of Symm: 6. X=4

Interval of Inc: 7. $(4, \infty)$

Dec: 8. $(-\infty, 4)$

Zeros: x = 2 and x= 6

Vertex Form: $y=(x-4)^2-4$

$y=a(x-h)^2+k$

Intercept Form: $y=(x-2)(x-6)$

$x=2$ $x=6$

$(x-2)=0$ $(x-6)=0$

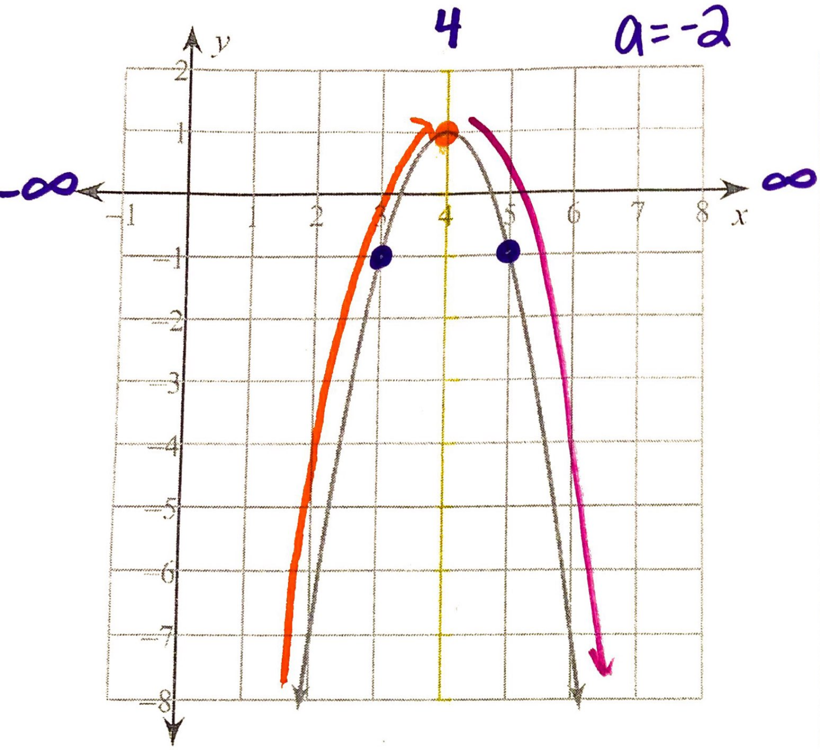
Standard Form: $y=x^2-8x+12$

$(x-4)(x-4)-4$

$x^2-8x+16-4$

Y-intercept: (0,12)

$f(0)=\underline{0^2}-\underline{8(0)}+12$



Transformations: 1. Stretch 2

2. Reflection

3. up

4. Right 4

Vertex: 5. (4,1)

Domain: 6. $(-\infty,\infty)$

Range: 7. $(-\infty,1]$

Axis of Symm: 6. $x=4$

Interval of Inc: 7. $(-\infty,4)$

Dec: 8. $(4,\infty)$

Vertex Form: $y=-2(x-4)^2+1$

Standard Form: $y=-2x^2+16x-31$

$f(0)=-2(0)^2+16(0)-31$

$f(0)=-31$

Y-intercept: $(0,-31)$